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Evaluation of blood alcohol levels in samples taken from medico-legal cases in Manaus, Northern Brazil

P.A.A. Canto [a], A.G.S. Rodrigues [b], S.G. Silva [b], F.G. Versiani [b], F.O.L. Versiani [b],

I.R.S. Magalhães [a,*]

[a] *Faculdade de Ciências Farmacêuticas, Universidade Federal do Amazonas (AM), Brasil*
[b] *Instituto de Criminalística, Departamento de Polícia Técnico-Científica, Secretaria de Segurança Pública do Estado do Amazonas (AM), Brasil*

*Endereço de e-mail para correspondência: imagalhaes@ufam.edu.br. Tel.: +55-92-3305-1181 Ramal 2007.

Resumo

Historicamente, o uso de álcool tem sido associado à ocorrência de diversos crimes, incluindo homicídios, estupros e violência sexual, entre outros. Portanto, o objetivo deste estudo foi avaliar os níveis de álcool no sangue (BAC) em amostras de ocorrências médico-legais em Manaus, norte do Brasil. Foi realizado um estudo observacional retrospectivo de maio de 2018 a abril de 2019 e o banco de dados do centro de referência foi empregado para esta finalidade. No total, foram avaliados 142 casos. A média de idade foi 36,2±10,9 anos (18-78 anos, IC 95% 34,34-38,42) e a maioria deles foi do sexo masculino (87,32%), solteiro (66,20%), possuía o ensino médio completo (47,89%) e residia na cidade de Manaus (61,70%). O BAC médio foi de 0,20±0,08 g/dL (0,1-0,64 g/dL, IC 95% 0,10-0,15). Em relação ao incidente, o dia da semana com mais casos foi o domingo (30,28%) e o início da manhã (24 a 06 horas; 40,14%). Apenas um pequeno percentual estava vivo antes da coleta de sangue (7,04%) e os acidentes de trânsito foram a ocorrência mais registrada (61,27%). A cocaína também foi encontrada em alguns casos (4,23%). Níveis de alcoolemia mais elevados foram observados para os casos de homicídio, enquanto os menores valores foram obtidos para os casos de suicídio (p=0,01). Houve correlação positiva fraca entre idade e a alcoolemia (r=0,27; p=0,01). Pela primeira vez, a investigação de alcoolemia em amostras de processos médicos legais foi realizada em Manaus. Desta forma, as autoridades podem desenvolver estratégias específicas para lidar com esse problema.

Palavras-Chave: Alcoolemia; Ocorrências médico-legais; Direção.

Abstract

Historically, the alcohol consumption has been associated to occurrence of different crimes, including homicides, rapes and sexual assault, among others. Hence, the aim of this study was to evaluate the blood alcohol levels (BAC) in samples taken from medico-legal cases in Manaus, northern Brazil. An observational retrospective study covering May-2018 through April-2019 was carried out and the database of the referral center was employed. In total, 142 cases were evaluated. The mean age of participants was 36.2 ± 10.9 years (range 18-78 years, CI 95% 34.34-38.42) and the majority of them was male (87.32%), single (66.20%), attended the secondary school level (47.89%) and living in the city of Manaus at the time of the incidence (61.70%). The mean BAC was 0.20 ± 0.08 g/dL (range 0.1-0.64 g/dL, CI 95% 0.10-0.15). In relation to the incident, the weekday with most cases was Sunday (30.28%) and in the early morning (24 to 06 hours; 40.14%). Only a small percent was alive before the blood draw (7.04%) and traffic accidents were the most registered occurrence (61.27%). Cocaine was also found in some cases (4.23%). Highest BAC levels were observed for the homicide cases whereas lowest BAC values were attained for the suicide cases (p=0.01). Furthermore, there was a weak positive correlation between age and BAC (r=0.27; p=0.01). For the first time, the study of BAC in samples taken from medico-legal cases was performed in Manaus. Taking into account the results, authorities may develop dedicated strategies to deal with this problem.

Keywords: Blood alcohol levels; Medico-legal issues; Driving.

1. INTRODUCTION

Historically, the alcohol consumption has been associated to occurrence of different crimes, including homicides, rapes and sexual assault, among others. Therefore, the investigation of variables related to this phenomenon has been done in several countries in order to develop measures to prevent or inhibit these actions [1].

The dynamics of alcohol consumption in Brazil has been studied intensively in the last years. The current drinking prevalence was 26% according to a household survey among Brazilian adults [2]. A population-based analysis further investigated the alcohol-drinking behaviors and its related variables throughout the nation [3]. The authors found that the prevalence of drinking was higher in younger men and that heavy episode drinking and drinking and driving are particularly problematic in Brazil.

Therefore, the combination of drinking and driving has been subject of several studies in Brazil. An investigation supported by the Brazilian Ministry of Health estimated the prevalence of driving after alcohol consumption among drivers in state capitals, which was higher among young male [4]. Drinking and driving was reported by nearly one quarter of those who drive car/motocycle in a nationally representative study [2]. In addition, a third of participants of a study self-reported that consumption of alcohol while returning from bars or restaurants in Curitiba [5].

Furthermore, the association of drinking and violent deaths has also been investigated in this country. Cruz *et al.* [6] aimed to identify risk factors associated with the different circumstances involving blood alcohol in the city of Rio de Janeiro in a seven-year time series analysis. Modelli and Lourenço [7] found a significant association between alcohol consumption and violent deaths in research performed at the Brazilian Federal District. Later, Gonçalves *et al*. [8] reported that alcohol consumption was linked to suicide deaths in a retrospective study carried in the city of São Paulo. Therefore, the aim of this study was to evaluate the blood alcohol levels (BAC) in samples taken from medico-legal cases in Manaus, Northern Brazil.

2. MATERIALS AND METHODS

2.1. Study setting

The Criminalistics Institute serves the state of Amazonas, located at the Northern region of Brazil, including its capital and major city Manaus, which has an estimated population of 2.2 million people and a Human Development Index (HDI) of 0.737, according to the Brazilian Institute of Geography and Statistics [9].

2.2. Study design

An observational, analytical, retrospective study was carried out, in which the records of BAC in medical-legal occurrences attended at the Criminalistics Institute from the major city of Northern Brazil were analyzed accordingly.

2.3. Data collection

The data for the study were collected from the Toxicology Laboratory database and encompassed the period between May 2018 and April 2019. Only cases from adults ($\geq$ 18 years) obtained from the referral center presenting BAC levels in g/dL obtained by a headspace gas chromatography–mass spectrometric (GC-MS) method were included. On average, there were about fifty-two requests for blood alcohol per month in this unit. In relation to sample collection and storage, blood was drawn using sodium fluoride/EDTA tubes and specimens were stored at -20 °C until analysis. All samples were analyzed in a period time less than 2 months.

Standardized data sheets were constructed for data collection using the information in the individual folders. Among the categories of analysis studied, socio-demographic data (gender, age, occupation, among others) and variables related to the requisition (circumstances, place of the incident, among others) were linked to the observed outcome (BAC).

2.4. Statistical analysis

Standard univariate analysis was applied to describe the sample, for continuous variables, measures of central tendency and the respective measures of dispersion were evaluated (mean values, standard deviations and 95% coefficient intervals); for categorical variables, percentages were expressed. The BAC data was assayed for normality using the Shapiro-Wilk test. To compare BAC with relevant variables, the Mann-Whitney or Kruskal-Wallis tests were used accordingly. Spearman's correlation coefficients were used to evaluate the relationship between age and BAC. The significance level adopted was 5% ($p < 0.05$%) and all statistical analyzes were performed using the STATA program.

2.5. Ethical aspects

The study protocol was analyzed and approved by the Research Ethics Committee of Universidade Federal do Amazonas, according to the Approval number 2.840.836.

3. RESULTS AND DISCUSSION

3.1. *Socio-demographic characteristics*

Considering the inclusion criteria, 142 cases were evaluated. Regarding socio-demographic variables, the mean age of participants was 36.2 ± 10.9 years (range 18-78 years, CI 95% 34.34-38.42) and the majority of them was male (87.3%), single (66.2%), attended the secondary school level (47.8%) and living in the city of Manaus at the time of the incidence (61.7%). The Table 1 summarizes the socio-demographic characteristics of the individuals studied.

Table 1. Socio-demographic characteristics of subjects included in the study.

Characteristics	Number of cases (%)
Sex	
Male	124 (87.32)
Female	18 (12.68)
Age (years)	
18-25	27 (19.29)
26-35	40 (28.57)
36-45	43 (30.71)
46-60	23 (16.43)
> 60	3 (2.14)
Not reported	4 (2.86)
Place of birth	
Manaus	87 (61.70)
Interior	26 (18.44)
Other places	22 (15.60)
Not reported	6 (4.26)
Marital status	
Single	94 (66.20)
Married	21 (14.79)
Common-law	12 (8.45)
Divorced	8 (5.63)
Not reported	7 (4.93)
Occupation	
Regular employed	81 (57.04)
Non-regular employed	44 (30.99)
Unemployed	11 (7.75)
Not reported	6 (4.23)
Level of education	
Illiterate	1 (0.70)
Primary school	56 (39.44)
Secondary school	68 (47.89)
Tertiary	10 (7.04)
Not reported	7 (4.93)

3.2. Blood alcohol levels

The mean BAC was 0.20 ± 0.08 g/dL (range 0.1-0.64 g/dL, CI 95% 0.10-0.15). There was no difference between males (0.21 ± 0.09 g/dL) and females (0.20 ± 0.08 g/dL) regarding BAC values (p=0.74, Figure 1). On the other hand, the highest individual values were found in man. Contradictory results regarding gender differences were observed in studies involving data obtained from deceased subjects [7,11]. In a Brazilian research, Modelli and Lourenço [7] reported average blood alcohol content of 1.74 g/l in women and 1.76 g/l in males. On the other hand, Almeida-González *et al*. [11] found median values of 1.54 and 1.70 g/L among males and females (respectively) in a study carried out in Spain.

In addition, individuals were dichotomized between having a partner (yes or no) and BAC levels in these groups were not different (0.19 ± 0.12 versus 0.20 ± 0.10 g/dL, respectively; p=0.94).
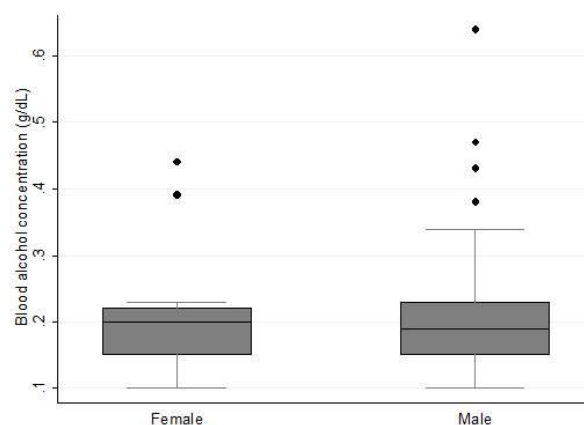
Figure 1. Distribution of blood alcohol concentration in males and females investigated in the study (p=0.74).

The BAC values were categorized according to the acute intoxication levels of ethanol [12]. Approximately half of the cases were in the 0.10-0.15 g/dL range (n=67, 47.18%), which is related to euphoria with reduction in judgement, motor function and reaction time. Other 54 individuals were in the 0.15-0.25 g/dL range (37.32%), which is associated to obvious signs of intoxication including impaired balance, speech, reaction time, emotional stability, vision, and comprehension. Therefore, these results are in line with the idea that alcohol acute intoxication is associated with risk-taking behavior, committing crimes, or being victim of a crime.

The Table 2 shows the characteristics of the medico-legal occurrences reported. In relation to the occurrence, the weekday with most cases was Sunday (30.28%) and in the early morning (24 to 06 hours; 40.14%). In spite of that, statistical analyses revealed no differences between workdays and weekend days or day and night cases considering BAC levels (p=0.10 and 0.58, respectively). A wide variation was observed regarding the number of cases within each month, with the highest observed in January (n=18, 12.68%) and the lowest found in September (n=5, 3.52%). In Brazil, the first month of the year is commonly related to job and scholar vacations, which may explain this observation and may be further investigated.

The city zones with most incidents were North and West (23.94 and 18.31, respectively), which are the districts presenting the majority of highways and entertainment areas of the city. However, no significant BAC differences were observed across the city zones observed, with average values ranging from 0.17 ± 0.01 g/dL (West) to 0.27 ± 0.03 g/dL (South-Central). On the other hand, De Boni *et al*. [13] found that high alcohol outlet density areas (HAOD) had higher proportions of interviewees with a BAC of >0.06% in a study carried out in Porto Alegre, Southern Brazil.

Only a small percent of participants was alive before the blood draw (7.04%). There was no difference between dead (0.20 ± 0.08 g/dL) and alive (0.22 ± 0.08 g/dL)

subjects regarding BAC values (p=0.42, Figure 2). However, deceased cases had the highest individual values. Out of the cases in which BAC was > 0.40 g/dL, which is linked to respiratory depression [12], all were related to dead victims. For instance, the studied case with the highest value was found dead in the countryside (0.64 g/dL).

Table 2. Characteristics of the medico-legal occurrences reported in the study.

Characteristics	Number of cases (%)
Individual	
Alive	10 (7.04)
Dead	132 (92.96)
Time of incident	
Early morning (12 am – 6 am)	57 (40.14)
Mid-to-late morning (6 am – 12 pm)	27 (19.01)
Afternoon (12 pm – 6 pm)	16 (11.27)
Evening (6 pm – 12 am)	37 (26.06)
Uncertain	5 (3.52)
Day of incident	
Sunday	43 (30.28)
Saturday	31 (21.83)
Monday	21 (14.79)
Friday	17 (11.97)
Wednesday	10 (7.04)
Thursday	10 (7.04)
Tuesday	9 (6.34)
City zones	
North	34 (23.94)
West	26 (18.31)
Other places	23 (16.20)
East	21 (14.79)
South	18 (12.68)
South-Central	12 (8.45)
West-Central	8 (5.63)
Occurrence	
Traffic accident	87 (61.27)
Homicide	18 (12.68)
Suicide	12 (8.45)
Overdose attempt	5 (3.52)
Others (drowning, accidental fall, etc).	20 (14.08)

Traffic accidents were the most registered occurrence (61.27%), followed by homicides. This circumstance also was the most registered incident in a study involving BAC levels in the city of Rio de Janeiro [6]. The mean BAC of 0.19 ± 0.00 g/dL was found for cases related to road traffic injuries, which is close to the findings from South Africa reported by Ehmke *et al*. [10]. In Brazil, the current federal law, which is popularly known as "Dry Law", prohibits driving under the influence of alcohol (Law 12,760/2012) [14]. Therefore, all cases were beyond this rule. This result is of concern because, according to a national survey, the habit of driving after the consumption of alcohol was higher in capitals from Northern Brazil than other cities of this country (29.9%) [4].
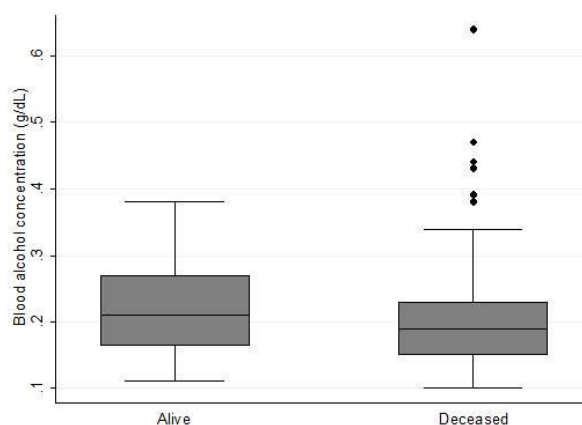

Figure 2. Distribution of blood alcohol concentration in dead and alive subjects investigated in the study (p=0.42).

A higher mean BAC value was observed for homicide cases (0.25 ± 0.02 g/dL, p=0.01). This result was also superior to the observed in other studies carried out in Australia and South Africa [15,16]. For instance, Darke *et al*. [15] found mean BAC of 0.14 g/dL in homicide cases from Sydney, Australia. Furthermore, Auckloo and Davies [16] reported mean BAC values of 0.16 g/dL in samples from homicide cases in south African city of Cape Town.

On the other hand, a lower mean BAC value was attained for suicide cases (0.18 ± 0.02 g/dL, p=0.01). Similar findings were reported by other studies involving sole suicide victims from Brazil [8,17]. Gonçalves *et al*. [8] reported mean BAC levels of 1.73 ± 0.08 g/L in a retrospective study involving suicide victims from the city of São Paulo. Another research focusing only suicide by hanging cases found mean BAC of 1.80 ± 0.90 g/L in the same city [17].

The utilization of alcohol with other substances including therapeutic and non-therapeutic drugs, deserves attention as well. Among drugs of abuse also screened during investigation, cocaine was also found in 4.23% of the analyzed cases. However, no differences regarding BAC levels were observed between cases negative or positive to other substances (p=0.51)

There was a weak positive correlation between age and BAC (Figure 3), which was statistically significant according to the Spearman`s correlation test (r=0.27; p=0.01). This result is consistent with the findings of Almeida-González *et al*. [11] who reported a trend between highest BAC and older ages in legally autopsied subjects from the Canary Islands in Spain.

This study has some limitations. For instance, the small sample size may restrain the generalization of the findings.

4. CONCLUSIONS

For the first time, the study of BAC in samples taken from medico-legal cases in the major city of Northern Brazil was carried out. Therefore, the determination of the

profile of individuals and occurrences related to this issue was performed. Taking into account this study, authorities may develop dedicated strategies to deal with this problem.
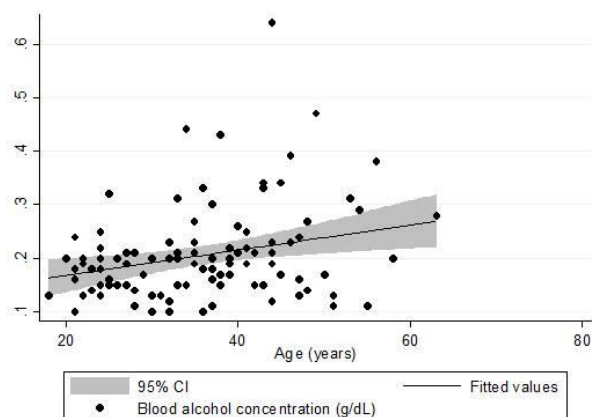

Figure 3. Correlation between blood alcohol concentration and age found in the study (r=0.27; p=0.01).

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